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(54) 【発明の名称】 表面特性に優れたフェライト系ステンレス鋼の製造方法

(57) 【要約】 (修正有)

【課題】 冷延時に発生する微小うねり(ローピング)が小さく表面特性に優れたフェライト系ステンレス鋼薄板。

【解決手段】 重量%で、C:0.025~0.055、N:0.001~0.015、Cr:15.0~18.0、Ti:0.005~0.10、Mn:0.01~1.0、Si:0.01~1.0、Al:0.015~0.025を含有し、以下、いずれも、S:0.010、P:0.04、Ni:0.5、Cu:0.5、Mo:0.2、O:0.010以下で、残部がFe及び不可避免的不純物からなり、 $r_p = 420 \times C + 470 \times N + 23 \times Ni + 12 \times Cu + 7 \times Mn - 11.5 \times Cr - 11.5 \times Si - 11 \times Mo - 52 \times Al - 49 \times Ti + 189$ の r_p が20~35%のフェライト系ステンレス鋼を1150~1300℃で熱間圧延し、粗圧延で1100℃以上での累積圧下率を40%以上とし、引き続き仕上げ圧延を実施して捲取温度を450~600℃とし、以後熱延板焼鈍を実施せず酸洗し冷延、最終焼鈍を実施する。

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(54) PRODUCTION OF FERRITIC STAINLESS STEEL EXCELLENT IN SURFACE CHARACTERISTIC

(57)Abstract:

PROBLEM TO BE SOLVED: To prepare a ferritic stainless steel sheet minimal in minute waviness (roping) occurring at the time of cold rolling and excellent in surface characteristic.

SOLUTION: A ferritic stainless steel, having a composition which consists of, by weight, 0.025-0.055% C, 0.001-0.015% N, 15.0-18.0% Cr, 0.005-0.10% Ti, 0.01-1.0% Mn, 0.01-1.0% Si, 0.015-0.025% Al, $\leq 0.010\%$ S, $\leq 0.04\%$ P, $\leq 0.5\%$ Ni, $\leq 0.5\%$ Cu, $\leq 0.2\%$ Mo, $\leq 0.010\%$ O, and the balance Fe with inevitable impurities and in which γ_p , represented by $\gamma_p = 420 \times C + 470 \times N + 23 \times Ni + 12 \times Cu + 7 \times Mn - 11.5 \times Cr - 11.5 \times Si - 11 \times Mo - 52 \times Al - 49 \times Ti + 189$, is regulated to 20-35%, is used. This steel is hot-rolled at 1150-1300° C, and cumulative draft at $\geq 1100^\circ$ C at the time of roughing is regulated to $\geq 40\%$, and successively finish rolling is performed. The resultant steel plate is coiled at 450-600° C coiling temp. and subjected, without hot rolled plate annealing, to pickling, to cold rolling, and then to final annealing.

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the manufacture approach of ferritic-stainless-steel sheet metal that the minute external waviness (roping) generated at the time of cold-rolling was small excellent in the surface characteristic, in the manufacture process of ferritic stainless steel.

[0002]

[Description of the Prior Art] Since nickel content is a low price few compared with austenitic stainless steel, ferritic stainless steel begins a kitchen instrument etc. and is used widely. In this case, since beautiful [surface] is needed, ferritic stainless steel is required to raise a surface characteristic.

[0003] However, it is known that the surface irregularity called RIJINGU as a product at the time of fabrication will tend to generate ferritic stainless steel. This RIJINGU is the irregularity of 5-50-micrometer height generated at the time of processing. The generating mechanism is also examined as the method of improving RIJINGU of ferritic stainless steel is examined variously conventionally, for example, it is described to steel 76(1990) P.1520 as iron.

[0004] As surface discontinuity, above-mentioned RIJINGU has so far been regarded as questionable. However, when cold-rolling of not the time of the fabrication of a product but the ferritic-stainless-steel hot-rolling plate is carried out, the minute wave generated on the front face of a cold-rolled plate cannot remain without even a final product disappearing, and it cannot be satisfied with recently of the surface grace searched for severely in recent years, and spoiling the value as a product poses a problem. This minute wave is a wave extended in height of 0.2 micrometers - about 0.5 micrometers on the front face of a cold-rolled plate in the rolling direction, and this wave is called roping in distinction from RIJINGU generated at the time of the fabrication of a product.

[0005] Moreover, the actual condition is inferior to SUS304 which is the representation steel type of austenitic stainless steel in respect of manufacturability -- SUS430 steel which is the typical steel type of ferritic stainless steel needs box annealing which needs dozens of hours after hot-rolling. Although many continuous-annealing-ized techniques of hot-rolling plate annealing and hot-rolling plate annealing abbreviation processes are also examined in order to simplify the manufacture process of SUS430 from such a viewpoint It is the component system which is characterized by the high pure flight system and high aluminum of low C, the reduction in N, and a raise in Ti in [system / of SUS430 usual steel / component] both cases, and is not established by the component system based on usual low Ti and low aluminum.

[0006]

[Problem(s) to be Solved by the Invention] Although roping was considered as the same phenomenon as RIJINGU until now It cannot be said that it is in RIJINGU generating at the time of fabrication, and generating of roping at the time of cold rolling about not necessarily good correspondence. Since cold-rolled rolling reduction becomes so small that it becomes high and, as for roping height, the generating mechanism of roping -- RIJINGU differs from generating behavior -- is not clear to the height becoming large, either, if, especially as for RIJINGU, working ratio becomes high, It is necessary to establish the

manufacture approach that roping can be reduced.

[0007] If roping generating can be reduced in the hot-rolling plate annealing abbreviation process that adding a new process to a process conventionally for roping reduction had large possibility of losing the merit of cheap ferritic stainless steel, and process saving progressed most, the ferritic stainless steel excellent in the surface characteristic can be offered still more cheaply. Therefore, the purpose of the invention in this application has generating of roping in offering the approach of manufacturing the ferritic stainless steel excellent in few surface characteristics, without making a process increase.

[0008]

[Means for Solving the Problem] this invention person etc. examined various methods of reducing roping in the manufacture process which omitted hot-rolling plate annealing of ferritic stainless steel. Consequently, the knowledge of the ability to reduce roping also in the process which omitted hot-rolling plate annealing was carried out by controlling a series of process conditions of a component, heating conditions, hot-rolling conditions, and **** conditions consistently.

[0009] The invention in this application is not based on independent control of a component or hot-rolling conditions, and needs the configuration which controls a series of following process conditions.

[0010] That is, the invention in this application is weight %. C : 0.025 - 0.055%, N : 0.001 - 0.015% Cr:15.0-18.0% S : 0.010% or less P : 0.04% or less, Ti: 0.005-0.10% Mn:0.01-1.0%, Si: 0.01-1.0% Less than [nickel:0.5%], Cu: Less than [0.5%] Less than [Mo:0.2%], aluminum: 0.015-0.025% O : 0.010% or less, Furthermore, B:0.005% or less and V:0.05% or less of one or more sorts are contained if needed. gammap shown by the bottom formula by the remainder consisting of Fe and an unescapable impurity The ferritic stainless steel which is 20 - 35% On the occasion of hot rolling, make whenever [stoving temperature] into 1150 degrees C or more 1300 degrees C or less, and accumulation rolling reduction in 1100 degrees C or more is made into 40% or more in rough rolling. It is the manufacture approach of ferritic stainless steel excellent in the surface characteristic characterized by carrying out acid washing and carrying out cold-rolling and the last annealing, without carrying out finishing rolling succeedingly, making **** temperature into 450-600 degrees C, and carrying out hot-rolling plate annealing henceforth.

gammap = 420xC + 470xN + 23xnickel + 12xCu + 7xMn - 11.5xCr - 11.5xSi - 11xMo - 52xaluminum - 49xTi + 189

[0011]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained. this invention person etc. conducted the experiment aiming at reduction of roping generated at the time of cold-rolling of ferritic stainless steel, and examined the experimental result in the detail. Consequently, in order to have omitted hot-rolling plate annealing and to have improved roping, it became clear that it is important to promote the gamma-phase distribution in the middle of hot-rolling. It is being in the middle of hot-rolling, and making it deposit rather than depositing gamma-phase [in this case] at the time of heating, and it became clear that roping was improved by being able to attain decentralization more and making a gamma-phase amount into 15% or more.

[0012] Therefore, a component system which is as a component in the middle of hot-rolling, and gamma-phase deposits or increases was good, and that roping cannot improve became whether to be ** by component system by which a gamma-phase volume fraction decreases during rough hot-rolling. Roping is improvable if the accumulation rolling reduction in 1100 degrees C or more exceeds 40% at 15% or more as an amount of gamma under rough hot-rolling. Moreover, by component system by which gamma-phase decreases to 15% or less during rough hot-rolling, although it becomes easy to produce recrystallization during hot-rolling, when recrystallization arose, it also became clear that it was not admitted that roping height decreases remarkably.

[0013] It is gammap which it is required to adjust from the above-mentioned viewpoint so that the amount of gamma may become 15% or more during rough hot-rolling as a component, and is shown by the bottom formula as this amount of gamma. When there was 20% or more, that the amount required during rough rolling of gamma is also securable became whether to be **.

gammap = 420xC + 470xN + 23xnickel + 12xCu + 7xMn - 11.5xCr - 11.5xSi - 11xMo - 52xaluminum - 49xTi + 189

[0014] Moreover, gammap It is related and is gammap. It is gammap, although roping improves so that

it is high. When it prescribes that a component exceeds 35, in the hot-rolling plate annealing abbreviation process of the invention in this application It is gammap in order that a bad influence may come out with the lug crack at the time of cold-rolling, and manufacturability other than a surface characteristic -- check the grain growth at the time of annealing, without gamma-phase disappearing only by annealing after cold-rolling while cold-rolling nature gets worse again, and reinforcement becomes high, and workability falls -- and the quality of the material. It could be 35% or less.

[0015] If whenever [stoving temperature] is set up as heating conditions so that a gamma-phase amount may serve as max at the time of heating, it is disadvantageous in respect of a gamma-phase activity, and it is important to set up whenever [stoving temperature] so that gamma-phase may deposit or increase during rough rolling. gammap gamma-phase is in the middle of hot-rolling, and it is made for at least 20% or more not to decrease -- being alike -- at the time of heating, it is required to make it the temperature to which gamma-phase decreases to some extent rather, and if it takes into consideration taking 40% or more of accumulation draft above 1100 degrees C, 1150 degrees C or more are required as whenever [stoving temperature]. However, since the surface section would cause abnormality grain growth by decarbonization and would cause a crack if it heats exceeding 1300 degrees C, the upper limit of whenever [stoving temperature] was made into 1300 degrees C.

[0016] It is satisfied with the above-mentioned viewpoint of a component and heating conditions, the relation between gamma-phase and hot-rolling conditions is making accumulation rolling reduction in 1100 degrees C or more into 40% or more, and it became clear that roping at the time of cold-rolling could be reduced. Making rolling reduction in 1100 degrees C or more into 40% or more, because it was required in order to make it distribute minutely after processing gamma-phase, it is because gamma deposit to a grain boundary serves as a subject in less than [this]. Moreover, it is gammap even if accumulation rolling reduction can secure 40%. Gamma-phase distribution becomes less uniform at less than 20%, although it is so desirable that the rolling reduction per one pass is high, even if it divides into number pass and carries out about rolling of 1100 degrees C or more with which a big and rough grain remains to a hot-rolling plate, and makes roping poor, it is effective, and about finish rolling, high-speed rolling-elevated-temperature finishing is desirable.

[0017] **** temperature after hot-rolling is made into an elevated temperature from 450 degrees C below 600 degrees C. From 600 degrees C, at an elevated temperature, gamma-phase decomposes into a ferrite and carbide and the improvement inclination of roping decreases. Moreover, since ferrite grain growth will be checked by the time martensite carries out a reverse transformation at the time of heat treatment after cold-rolling and the yield point becomes high, when premised on the process which metamorphosed into martensite at low temperature 450 degrees C or less, and was made to distribute gamma-phase minutely like the invention in this application, and omitted hot-rolling plate annealing, although remarkable low-temperature **** improves a roping property, in order to make the quality of the material hard, the minimum of **** temperature was taken as the temperature exceeding 450 degrees C.

[0018] As a result of examining the component range, and the above-mentioned roping reduction approach With weight % C : 0.025 - 0.055%, N : 0.001 - 0.015% Cr:15.0-18.0% S : 0.010% or less P : 0.04% or less, Ti: 0.005-0.10% Mn:0.01-1.0%, Si: 0.01-1.0% Less than [nickel:0.5%], Cu: Less than [0.5%] Less than [Mo:0.2%], aluminum: 0.015-0.025% O : 0.010% or less, B:0.005% or less and V:0.05% or less of one or more sorts were contained further if needed, and it became clear that it was realized in the ferritic stainless steel with which the remainder consists of Fe and an unescapable impurity. .

[0019] The reason for limitation of a component is explained below.
C: C is especially harmful in respect of corrosion resistance, and although it has a bad influence on the corrosion resistance of a weld zone, in order to secure reinforcement and a gamma-phase amount proper, a certain extent is required. Since workability and ductility would deteriorate if the amounts of gamma run short at less than 0.025%, and a ferrite grain makes it big and rough from a gamma-phase viewpoint and it adds exceeding 0.055%, C could be 0.025 - 0.055%.

[0020] N: Since it will become high intensity and workability will deteriorate if ***** is industrially

difficult for less than 0.001% and it adds exceeding 0.015%, although corrosion resistance and workability of N are so desirable that there are few contents like C, add N in 0.001 - 0.015% of range. [0021] Cr:Cr is the main element of the ferritic stainless steel of the invention in this application, and in order to secure corrosion resistance, it is necessary to add it 15% or more. However, even if it added exceeding 18%, feeding habits improved, but since C for securing the amount of gamma, N, and the amount of Mn increased and workability and toughness changed, the upper limit of Cr was made into 18%.

[0022] S: S degrades ductility, toughness, etc., and also from a corrosion resistance viewpoint, since it is harmful, it may be 0.010% or less.

P: P is harmful also workability, toughness, and in respect of corrosion resistance, and make the content into 0.040% or less so desirably that it is few.

[0023] Ti: It is an element required since N is fixed from a viewpoint of workability in the invention in this application, and add 0.005% or more. However, when it adds superfluously, an upper limit -- the need that they add gamma stabilization element so much since the fixed effects of N are that the improving thing price becomes high and a ferrite formation element with powerful Ti itself arises -- is 0.1% or less. It is desirable to consider as 0.05% or less from a viewpoint of roping.

[0024] Although Mn:Mn is added as a deoxidation element, since the effectiveness is saturated with less than 0.01% even if effectiveness adds exceeding 1% rather than is enough, it adds at 0.01 - 1.0%.

[0025] Since Si:Si will promote embrittlement remarkably and will degrade ductility and toughness if there is no effectiveness sufficient at less than 0.01% and it adds exceeding 1%, although used as a deoxidizer, it is added at 0.01 - 1.0%.

[0026] nickel:nickel can be used as a gamma-phase stabilization element. However, since gamma-phase cannot decompose during subsequent heat treatment since gamma-phase will be remarkably stable if it adds so much, but workability deteriorates, it adds at 0.5% or less.

Cu:Cu can be used as a gamma-phase stabilization element. However, since reinforcement will rise remarkably by Cu if it adds so much, it adds at 0.5% or less.

Mo:Mo can be used as a ferrite phase stabilization element. However, since reinforcement will rise and workability will deteriorate if it adds so much, it is used at 0.2% or less.

[0027] It is required to consider as 0.015% or more which aluminum:aluminum is used as a deoxidation element and can be used also for immobilization of N. Moreover, aluminum was a powerful ferrite stabilization element, and if it is made to contain so much, in order to decrease the amount of gamma, it could be 0.025% or less.

O: Since O degraded the toughness of a hot-rolling plate or caused nozzle plugging at the time of casting, crack generating, and toughness degradation of a hot-rolling plate, it could be 0.01% or less in the invention in this application.

[0028] One or more sorts of B and V can be made to contain if needed in this invention.

B: Since B fixes N, it can improve workability. However, even if it added superfluously, since the effectiveness was saturated, it was made into 0.005% or less.

V:V fixes C and N, and since it can improve workability, it can add them at 0.05% or less as a selection element.

[0029]

[Example] The ferritic stainless steel of the component shown in Table 1 was ingoted by the vacuum melting of a lab, and 50kg steel ingot with a thickness of 100mm was manufactured. Then, rough rolling was carried out to 20mm with five pass after heating on the conditions shown in Table 2, finish hot-rolling was carried out with six pass from 20mm to 5-3mm, that ***** was inserted in the 750-350-degree C furnace, carried out after [the 1 hour retention] furnace cooling, and **** was simulated. The **** temperature of front Naka is the retention temperature of this simulation. Then, cold-rolling of the rate of cold rolling was changed and carried out to the thickness of 2.0-0.4mm after acid washing with the sulfuric acid, and roping height was evaluated.

[0030] Roping performed cold-rolling to 0.4mm after acid washing, measured the above-mentioned hot-rolling plate with the roughness plan about 10mm length in the direction of a right angle to the direction

of cold-rolling, and made it roping height with the maximum of external waviness height. Three places of this measurement were carried out and that average estimated roping. The average of the roping maximum height whose evaluation is three places evaluated A ranks and 0.15 micrometers or more less than 0.25 micrometers for less than 0.15 micrometers, and evaluated C rank and 0.35 micrometers or more for B ranks and 0.25 micrometers or more - less than 0.35 micrometers as a D rank. If it is A and B ranks, it will not become a problem from the point of surface grace. As shown in Table 2, each invention-in-this-application material had roping height as small as less than 0.25 micrometers, and showed the outstanding surface characteristic.

[0031]

[Table 1]

No.	成分 (wt%)														7P
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	O	N	その他	
A	0.039	0.30	0.76	0.025	0.0046	16.51	0.10	0.05	0.02	0.020	0.012	0.0033	0.0071		22.3
B	0.051	0.41	0.86	0.019	0.0054	16.08	0.09	0.02	0.09	0.022	0.074	0.0045	0.0069		26.8
C	0.048	0.22	0.80	0.027	0.0072	16.31	0.16	0.17	0.02	0.020	0.009	0.0022	0.0128		34.7
D	0.054	0.26	0.87	0.024	0.0048	17.05	0.04	0.01	0.03	0.024	0.037	0.0026	0.0101	B:0.0043	21.1
E	0.048	0.33	0.66	0.031	0.0056	16.27	0.15	0.05	0.04	0.021	0.022	0.0041	0.0145		31.1
F	0.035	0.14	0.78	0.030	0.0049	16.68	0.16	0.14	0.06	0.024	0.069	0.0037	0.0109		20.9
G	0.043	0.35	0.31	0.017	0.0043	16.45	0.11	0.12	0.10	0.018	0.045	0.0029	0.0097	V:0.0025	20.3
H	0.053	0.48	0.89	0.020	0.0033	17.02	0.21	0.16	0.04	0.020	0.015	0.0044	0.0142	B:0.0024 V:0.0020	27.4
I	0.036	0.28	0.44	0.029	0.0060	16.03	0.15	0.24	0.06	0.023	0.008	0.0036	0.0108	V:0.0042	28.8
J	0.044	0.29	0.18	0.022	0.0051	16.11	0.07	0.01	0.07	0.017	0.020	0.0030	0.0083		23.1
K	0.054	0.20	0.20	0.033	0.0068	16.65	0.05	0.03	0.02	0.024	0.009	0.0045	0.0093		23.3
L	0.075	0.34	0.30	0.032	0.0066	16.26	0.12	0.06	0.11	0.025	0.021	0.0040	0.0250		43.4
M	0.020	0.30	0.75	0.025	0.0038	16.30	0.05	0.04	0.09	0.023	0.018	0.0041	0.0090		14.5
N	0.035	0.29	0.83	0.024	0.0036	16.59	0.09	0.07	0.05	0.020	0.010	0.0037	0.0117		21.7
O	0.043	0.32	0.56	0.022	0.0075	16.22	0.15	0.08	0.06	0.017	0.008	0.0046	0.0124		26.0
P	0.051	0.46	0.15	0.026	0.0049	16.43	0.09	0.02	0.04	0.019	0.040	0.0033	0.0098		20.8
Q	0.052	0.24	0.80	0.037	0.0078	18.18	0.06	0.03	0.03	0.024	0.017	0.0034	0.0087		31.0

*下線は本願の条件から外れていることを示す。

ローピング評価基準…A:0.15 μ m未満、B:0.15~0.25 μ m未満、C:0.25~0.35 μ m未満、D:0.35 μ m以上

[0032]

[Table 2]

No.	加熱温度 (℃)	熱 延				冷 延		備考
		粗圧延		仕上圧延 終了温度 (℃)	捲取温度 (℃)	圧下率 (%)	ローピング 評 点	
		1100℃以上 累積圧下率(%)	粗仕上げ 温度 (℃)					
A	1250	70	1068	940	475	70	A	本発明例
B	1180	50	1015	925	550	87	B	本発明例
C	1230	40	1034	865	500	80	B	本発明例
D	1180	40	1065	870	500	65	B	本発明例
E	1250	40	1075	912	500	55	B	本発明例
F	1220	70	1060	887	475	73	A	本発明例
G	1180	80	1027	931	575	80	A	本発明例
H	1180	40	1034	894	510	80	B	本発明例
I	1250	70	1087	840	475	70	A	本発明例
J	1150	45	1002	869	600	87	B	本発明例
K	1150	50	1011	874	500	70	A	本発明例
L	1200	45	1018	869	550	80	B	比較例(聯式)
M	1180	50	1032	874	500	70	D	比較例
N	1150	30	953	861	600	70	D	比較例
O	1100	0	898	832	500	70	D	比較例
P	1150	40	994	850	750	87	C	比較例
Q	1150	50	1012	849	350	70	D	比較例

[0033]

[Effect of the Invention] As mentioned above, this invention can reduce roping at the time of cold-rolling which is the trouble of the surface characteristic of ferritic stainless steel in a hot-rolling plate annealing abbreviation process, and contributes to an improvement of a surface characteristic by low cost.

[Translation done.]

(2)

特開平10

1

【特許請求の範囲】

【請求項1】重量%で、

C : 0.025~0.055%、

N : 0.001~0.015%、

Cr : 15.0~18.0%、

S : 0.010%以下、

P : 0.04%以下、

Ti : 0.005~0.10%、

Mn : 0.01~1.0%、

Si : 0.01~1.0%、

Ni : 0.5%以下、

Cu : 0.5%以下、

Mo : 0.2%以下、

Al : 0.015~0.025%、

O : 0.010%以下

を含有し、残部がFe及び不可避免的不純物からなり、下式で示される γ_p が20~35%であるフェライト系ステンレス鋼を、熱間圧延に際し加熱温度を1150℃以上1300℃以下にし、鋳圧延において1100℃以上での累積圧下率を40%以上とし、引き続き仕上げ圧延を実施して捲取温度を450~600℃とし、以後熱延板焼鈍を実施することなく酸洗し冷延、最終焼鈍を実施することを特徴とする表面特性に優れたフェライト系ステンレス鋼の製造方法。

$$\gamma_p = 420 \times C + 470 \times N + 23 \times N_i + 12 \times C_u + 7 \times Mn - 11.5 \times Cr - 11.5 \times Si - 11 \times Mo - 52 \times Al - 49 \times Ti + 189$$

【請求項2】重量%で、

C : 0.025~0.055%、

N : 0.001~0.015%、

Cr : 15.0~18.0%、

S : 0.010%以下、

P : 0.04%以下、

Ti : 0.005~0.10%、

Mn : 0.01~1.0%、

Si : 0.01~1.0%、

Ni : 0.5%以下、

Cu : 0.5%以下、

Mo : 0.2%以下、

Al : 0.015~0.025%、

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小うねり（ローピング）が小さく表面特ライト系ステンレス鋼薄板の製造方法に【0002】

【従来の技術】フェライト系ステンレスイト系ステンレス鋼に比べてN_i含有量であるため、厨房器具等をはじめ広く使この場合、表面の美麗さが必要となるた向上させることがフェライト系ステンレる。

10 【0003】しかし、フェライト系ステ品として成形加工時にリジングと言われ生しやすいことが知られている。このリに発生する5~50μm高さの凹凸であ系ステンレス鋼のリジングを改善する方々検討されており、例えば、鉄と鋼76P.1520に述べられているように発ついても検討されている。

【0004】これまで表面欠陥としては、グが問題視されてきた。しかしながら、成形加工時ではなく、フェライト系ステを冷延したときに冷延板の表面に発生す、が最終製品まで消えずに残り、近年厳しる表面品位を満足することができず、誤を損なうことが問題となっている。この冷延板の表面に高さ0.2μm~0.5方向に伸びたうねりであり、このうねり工時に発生するリジングと区別してローている。

【0005】またフェライト系ステンレ鋼種であるSUS430鋼は、熱延後にとする箱焼鈍を必要とするなど製造性のイト系ステンレス鋼の代表鋼種であるS劣っているのが実状である。このような430の製造プロセスを簡略化するため連続焼鈍化技術や熱延板焼鈍省略プロセ、く検討されているが、どちらの場合も通0鋼の成分系よりは低C、低N化、高Tイト系や高Alを特徴とするような成分富の低Ti、低Alを基本とする成分系ない。

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【0007】ロービング低減のために従来工程に新工程を付加することは、安価なフェライト系ステンレス鋼のメリットを失う可能性が大きく、最も省工程が進んだ熱延板焼鈍省略プロセスでロービング発生を低減できれば、表面特性が優れたフェライト系ステンレス鋼をさらに安価に提供できることとなる。従って本願発明の目的は工程を増加させることなく、ロービングの発生が少ない表面特性に優れたフェライト系ステンレス鋼を製造する方法を提供することにある。

【0008】

【課題を解決するための手段】本発明者等は、フェライ*

C : 0.025~0.055%, N : 0.001~0.015%,
Cr : 15.0~18.0%, S : 0.010%以下,
P : 0.04%以下, Ti : 0.005~0.10%,
Mn : 0.01~1.0%, Si : 0.01~1.0%,
Ni : 0.5%以下, Cu : 0.5%以下,
Mo : 0.2%以下, Al : 0.015~0.025%,
O : 0.010%以下.

さらに必要に応じて、B : 0.005%以下、V : 0.05%以下の1種以上を含有し、残部がFe及び不可避的不純物からなり、下式で示される γ_p が20~35%であるフェライト系ステンレス鋼を、熱間圧延に際し加熱温度を1150℃以上1300℃以下にし、粗圧延において1100℃以上での累積圧下率を40%以上とし、引き続き仕上げ圧延を実施して捲取温度を450~600℃とし、以後熱延板焼鈍を実施することなく酸洗し冷延、最終焼鈍を実施することを特徴とする表面特性に優れたフェライト系ステンレス鋼の製造方法である。

$$\gamma_p = 420 \times C + 470 \times N + 23 \times Ni + 12 \times Cu + 7 \times Mn - 11.5 \times Cr - 11.5 \times Si - 11 \times Mo - 52 \times Al - 49 \times Ti + 189$$

【0011】

【実施の形態】以下、本発明の実施の形態について説明する。本発明者等はフェライト系ステンレス鋼の冷延時に発生するロービングの低減を目的とした実験を行い、実験結果を詳細に検討した。その結果、熱延板焼鈍を省略してかつロービングを改善するには、熱延途中の γ 相の分散を促進させることが重要であることが判明した。この際の γ 相は加熱時に析出させるよりも、熱延途中で析出させることで、より分散化が図れ、また γ 相量を1

*ト系ステンレス鋼の熱延板焼鈍を省略し、においてロービングを低減する方法を種々の結果、成分、加熱条件、熱延条件、捲プロセス条件を一貫して制御することで、省略したプロセスでもロービングを低減見した。

【0009】本願発明は、成分や熱延条件によるものではなく、以下の一連のプロセス構成を必要とする。

10 【0010】すなわち、本願発明は、重

20 ロービング高さが著しく減少することによりとも判明した。

【0013】上記の観点から、成分とし延中に15%以上となるように調整する。この γ 量としては下式で示される γ_l あれば、粗圧延中に必要な γ 量が確保でとなった。

$$\gamma_p = 420 \times C + 470 \times N + 23 \times u + 7 \times Mn - 11.5 \times Cr - 11.5 \times Si - 11 \times Mo - 52 \times Al - 49 \times Ti + 189$$

30 【0014】また γ_p に関しては、 γ_p が35を超え、規定すると本願発明の熱延板焼鈍省略プロセス時の耳割れや、また冷延性が悪化するの焼鈍のみでは γ 相が消えずに焼鈍時のし、また強度が高くなり加工性が低下す、以外の製造性、材質で悪影響がでるため以下とした。

40 【0015】加熱条件としては、加熱時となるように加熱温度を設定すると γ 相であり、粗圧延中に γ 相が析出または増、熱温度を設定することが重要である。 γ_l

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できることが判明した。1100℃以上での圧下率を40%以上としたのは、 γ 相を加工後微細に分散させるために必要であるためであり、これ以下では粒界への γ 析出が主体となるためである。また累積圧下率が40%を確保できても、 r_p が20%未満では γ 相の分散が均一でなくなり粗大粒が熱延板に残存し、ロービングを不良とする1100℃以上の圧延に関しては、1パスあたりの圧下率が高いほど好ましいが、数パスに分けて実施しても効果があり、また仕上圧延に関しては高速圧延・高温仕上げが望ましい。

【0017】熱延後の捲取温度は600℃以下で450℃より高温とする。600℃より高温では γ 相がフェラ*

C : 0.025~0.055%, N : 0.001~0.015%,
Cr : 15.0~18.0%, S : 0.010%以下,
P : 0.04%以下, Ti : 0.005~0.10%,
Mn : 0.01~1.0%, Si : 0.01~1.0%,
Ni : 0.5%以下, Cu : 0.5%以下,
Mo : 0.2%以下, Al : 0.015~0.025%,
O : 0.010%以下,

さらに必要に応じて、B : 0.005%以下、V : 0.05%以下の1種以上を含有し、残部がFe及び不可避の不純物からなるフェライト系ステンレス鋼において成り立つことが判明した。

【0019】以下に成分の限定理由を述べる。

C : Cは耐食性の点では有害であり特に溶接部の耐食性に悪影響を与えるが、強度および γ 相量を適正に確保するためにはある程度は必要である。 γ 相の観点からは0.025%未満では γ 量が不足しフェライト粒が粗大化する、また0.055%を超えて添加すると加工性、延性が劣化するためにCは0.025~0.055%とした。

【0020】N : NはCと同様に含有量が少ないほど耐食性、加工性が好ましいが0.001%未満にすることは工業的には困難であり、また0.015%を超えて添加すると高強度となり加工性が劣化するためにNは0.001~0.015%の範囲で添加する。

【0021】Cr : Crは本願発明のフェライト系ステンレス鋼の主要元素であり、耐食性を確保するためには15%以上添加する必要がある。しかし、18%を超えて添加しても食性は向上するが、 γ 量を確保するための

*イトと炭化物に分解してしまい、ロービが減少する。また450℃以下の低温でイトに変態してしまい、本願発明のように散らせ、かつ熱延板焼鈍を省略したプロセスの場合、冷延後の熱処理時にマルテンサるまでにフェライト粒の成長を阻害し降ため、著しい低温捲取はロービング特性質を硬質にするため捲取温度の下限は4温度とした。

10 【0018】そして、成分範囲について上記のロービング低減方法は、重量%で

20 以上添加する。しかし、過剰に添加するは向上するものの価格が高くなることや、なフェライト形成元素であるため γ 安定添加する必要性が生じるなど上限は0.05%とが望ましい。

【0024】Mn : Mnは脱酸元素として0.01%未満では効果が十分ではなく、添加してもその効果が飽和するため、で添加する。

30 【0025】Si : Siは脱酸剤として0.01%未満では十分な効果がなく、で添加すると脆化を著しく促進させ延性をせるので0.01~1.0%で添加する。

【0026】Ni : Niは γ 相安定化元素である。但し多量に添加すると γ 相が著しく、 γ 相がその後の熱処理中に分解できするため0.5%以下で添加する。

Cu : Cuは γ 相安定化元素として使用量に添加するとCuによって強度が著しく0.5%以下で添加する。

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め、本願発明においては0.01%以下、とした。

【0028】本発明では必要に応じてB、Vの1種以上を含有させることができる。

B：BはNを固定するため、加工性を改善することができる。しかし過剰に添加してもその効果は飽和するため、0.005%以下とした。

V：VはCやNを固定し、加工性を改善できるため選択元素として0.05%以下で添加できる。

【0029】

【実施例】表1に示す成分のフェライト系ステンレス鋼10をラボの真空溶解で溶製し、厚み100mmの50kg鋼塊を製造した。この後、表2に示す条件で加熱後、粗圧延を5パスで20mmまで実施し、仕上熱延を20mmから5～3mmまで6パスで実施し、そのま熱延板を750～350℃の炉に挿入し1時間保定後炉冷して捲取をシミュレートした。表中の捲取温度はこのシミュレートの保定温度である。この後、硫酸で酸洗後、厚み2.0～0.*

*4mmまで冷間圧延率を変えて冷延し、ロ評価した。

【0030】ローピングは、上記熱延板、4mmまで冷延を行い、冷延方向に対して1mm長さについて粗度計で測定し、うねり待ってローピング高さとした。この測定し、その平均値でローピングを評価した。所のローピング最大高さの平均が0.1ランク、0.15μm以上0.25μm未満、0.25μm以上～0.35μm未満、0.35μm以上をDランクとして評価の点からはA、Bランクであれば問題ない。表2に示すように、本願発明材はいグ高さが0.25μm未満と小さく、優示した。

【0031】

【表1】

No.	成分 (wt%)														71
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	O	N	その他	
A	0.039	0.30	0.76	0.025	0.0046	16.51	0.19	0.05	0.02	0.020	0.012	0.0033	0.0071		23
B	0.051	0.41	0.86	0.018	0.0054	16.08	0.09	0.02	0.09	0.022	0.074	0.0045	0.0069		26
C	0.048	0.22	0.80	0.027	0.0072	16.21	0.16	0.17	0.02	0.020	0.009	0.0022	0.0128		34
D	0.054	0.26	0.87	0.024	0.0048	17.05	0.04	0.01	0.03	0.024	0.037	0.0026	0.0101	B:0.0043	21
E	0.048	0.23	0.66	0.021	0.0056	16.27	0.15	0.05	0.04	0.021	0.023	0.0041	0.0145		21
F	0.026	0.14	0.78	0.030	0.0049	16.68	0.18	0.14	0.06	0.024	0.069	0.0087	0.0109		20
G	0.043	0.35	0.31	0.017	0.0043	16.45	0.11	0.12	0.10	0.018	0.045	0.0029	0.0697	F:0.025	20
H	0.053	0.48	0.69	0.020	0.0033	17.02	0.21	0.16	0.04	0.020	0.015	0.0044	0.0142	B:0.0024 V:0.020	27
I	0.036	0.28	0.44	0.029	0.0060	16.03	0.15	0.24	0.06	0.023	0.008	0.0086	0.0108	F:0.042	28
J	0.044	0.29	0.18	0.022	0.0051	16.11	0.07	0.01	0.07	0.017	0.020	0.0080	0.0088		23
K	0.064	0.20	0.20	0.038	0.0063	16.68	0.06	0.03	0.02	0.024	0.030	0.0045	0.0693		22
L	0.075	0.34	0.30	0.032	0.0056	16.26	0.12	0.03	0.11	0.025	0.021	0.0040	0.0250		22
M	0.020	0.30	0.75	0.025	0.0088	16.80	0.05	0.04	0.09	0.028	0.018	0.0041	0.0090		14
N	0.035	0.28	0.88	0.024	0.0086	16.59	0.08	0.07	0.05	0.020	0.010	0.0037	0.0117		21
O	0.043	0.82	0.56	0.022	0.0075	13.22	0.15	0.08	0.06	0.017	0.008	0.0046	0.0124		28
P	0.051	0.43	0.15	0.023	0.0049	16.43	0.09	0.02	0.04	0.019	0.040	0.0033	0.0098		20
Q	0.052	0.24	0.80	0.037	0.0078	16.18	0.05	0.03	0.08	0.024	0.017	0.0034	0.0087		31

*下線は本願の条件から外れていることを示す。

ローピング評価基準…A:0.15μm未満、B:0.15～0.25μm未満、C:0.25～0.35μm未満、D:0.35μm以上

【0032】

【表2】

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No.	加熱温度 (℃)	熱 延				冷 延		備考
		粗延延		仕上延延 終了温度 (℃)	再延延度 (℃)	圧下率 (%)	ローピング 評 点	
		1100℃以上 累積圧下率(%)	粗延上げ 温度 (℃)					
A	1250	70	1055	940	475	70	A	本発明例
B	1180	50	1015	925	550	87	B	本発明例
C	1230	40	1034	865	500	80	B	本発明例
D	1180	40	1055	870	500	65	B	本発明例
E	1250	40	1075	912	500	55	B	本発明例
F	1220	70	1030	887	475	75	A	本発明例
G	1180	60	1027	951	575	80	A	本発明例
H	1180	60	1034	894	510	80	D	本発明例
I	1250	70	1037	840	475	70	A	本発明例
J	1150	45	1002	869	600	87	D	本発明例
K	1150	50	1011	874	580	70	A	本発明例
L	1200	45	1013	869	550	80	B	比較例(融試)
M	1180	50	1032	874	530	70	D	比較例
N	1130	20	983	851	600	70	D	比較例
O	1100	0	896	832	500	70	D	比較例
P	1150	40	894	850	750	87	C	比較例
Q	1150	60	1012	849	350	70	D	比較例

【0033】

【発明の効果】上記のように、本発明はフェライト系ステンレス鋼の表面特性の問題点である冷延時のローピン

グを熱延板焼鈍省略プロセスにて低減で表面特性の改善に寄与する。